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Study on the effects of music on the health of geriatric inpatients

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Résumé

La musique a été utilisée afin d'améliorer la santé, la communication et la qualité de vie. Nous avons utilisé cette perspective dans une unité de courte durée gériatrique en menant une étude randomisée contrôlée évaluant l'impact de la participation à un mini-concert de musique (groupe intervention, n = 20) comparativement à une séance de télévision (groupe contrôle, n = 16). L'objectif primaire était de déterminer l'effet de ces interventions sur la mobilité (via le test du lever de chaise et la vitesse de marche). Ceci n'a pas pu être réalisé à cause d'une grande variation des mesures et du faible nombre de participants ayant complété les tests (n = 17), suggérant que l'évaluation de l'effet de la musique sur la mobilité n'est peut-être pas réaliste chez cette population. Par contre, l'objectif secondaire qui était de déterminer l'impact sur les émotions (via le *Visual Analog Mood Scale* et le *Observed Emotional Rating Scale* évaluant respectivement les émotions auto-rapportées et observées) et les habiletés communicationnelles (via l'échelle *Communication Behavior in Dementia*) a mené à des résultats clairs. Les participants du groupe musique ont rapporté une plus grande augmentation du *Bonheur* et démontré plus de *Plaisir* comparativement au groupe télévision. Également, les participants du groupe musique ont démontré une plus grande augmentation des émotions positives et une plus grande diminution des émotions négatives. Pour les habiletés communicationnelles, les analyses n'ont pas été réalisées vu un faible accord inter-juge. Cette étude démontre qu'un concert de musique peut améliorer les émotions des patients admis en gériatrie.

Mots-clés : musique, gériatrie, mobilité, émotion, communication

Abstract

Music has long been used to improve health, communication and quality of life. We used music in a similar perspective inside a Geriatric Assessment Unit. We conducted a randomized controlled study to evaluate the impact of attendance to a live music concert (intervention group, n = 20) compared to a documentary-watching session (control group, n = 16). The primary objective was to determine the effect of the interventions on mobility using the Timed Up and Go and gait speed tests. This was not fulfilled, as the mobility measures data could not be analyzed due to the high variability of the measure and small number of participants (n = 17) who completed the tests, suggesting that assessing the effect of music on mobility may not be feasible in this population. In contrast, the secondary objective of examining the effect on emotions (measured with the Visual Analog Mood Scale and the Observed Emotional Rating Scale which respectively evaluate self-reported and observed emotions) and communication skills (measured with the Communication Behavior in Dementia scale) led to clear results. The participants in the music group experienced enhanced happiness and displayed more pleasure than the participants in the documentary-watching group. Participants in the music sessions also displayed a higher increase of positive emotions and a more pronounced decrease of negative emotions, as compared to the control group. For the communication skills, analyses were not pursued due to only fair inter-rater agreement. The results of this study show that a live music concert can improve emotions in geriatric inpatients.

Keywords : music, geriatric, mobility, emotion, communication

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List of abbreviations

BPSD: Behavioral and Psychological Symptoms of Dementia

CODEM: Communication Behavior in Dementia

GAU: Geriatric Assessment Unit

MFS: Morse Fall Scale

OERS: Observed Emotional Rating Scale

TUG: Timed Up and Go

VAMS: Visual Analog Mood Scale

Music evokes emotion and emotion can bring it's memory

(Oliver Sacks)

Remerciements

Je dois avouer que considérant cette section facultative, il m’est venu à l’esprit de tout simplement sauter cette section. Par contre, ayant entrepris de faire cette maîtrise alors que j’étais enceinte et que je complétais ma résidence en gériatrie, je me devais de remercier les personnes sans qui rien n’aurait été possible.

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1. Introduction

Music has been used as a therapy for multiple years in order to improve health, communication and quality of life. It has been reported to have multiple benefits including improved quality of life, pain control, lower anxiety, and positive emotions in patients (Evans, 2002; Parker, Mills, & Abbey, 2008; Richards, Johnson, Sparks, & Emerson, 2007). Music is not only known to be beneficial for patients; it is also inexpensive and free of adverse effects. However, only a few studies looked at the impact of music on the geriatric population, and even less so in the hospital environment.

This study aims to determine the impact of a musical intervention on the health of patients admitted to a Geriatric Assessment Unit.

1.1 Geriatric Needs

Canada is experiencing a rapid aging of its population. This has significant repercussions on the health care system, as more elderly patients require medical attention and, compared to younger populations, use up a disproportionate number of resources. As an example, in 2011, patients aged 65 years and older represented 14% of the population, but they were occupying 40% of acute hospital care beds (Canadian Institute for Health Information CRHI, 2011). Hospitalized elderly patients are at significant risk of functional decline as well as many other health outcomes including a longer length of hospital stay, greater mortality, higher nursing home placement, and more numerous falls (da Costa, Rutjes, Mendy, Freund-Heritage, & Vieira, 2012; Hoogerduijn, Schuurmans, Duijnstee, de Rooij, & Grypdonck, 2007). Considering that age-related burden of non-fatal health outcomes is one of the main challenges faced by hospitals, it is mandatory to assess and address the needs of the growing number of geriatric patients. In order to do so, the Canadian Medical Association suggests six strategies which should be implemented; one of those being an investment in an environment as well as a community which should be "age friendly" (Canadian Medical Association, 2016). One of the ways to do so could be the use of music.

1.2 Neurobiology of music listening

Listening to music involves a complex neural basis. When listening to music, sound waves are transduced into neural impulses which are transmitted to the brainstem (Rauschecker & Shannon, 2002). This signal is afterwards transmitted mainly to the auditory cortex. However, further processing of music is complex as different areas of the brain are required to analyse musical sequences. In fact, listening to music requires perception of harmony, tonality as well as attentional skills and working memory which are both necessary to manipulate stored information (Peretz & Zatorre, 2005). Music listening also requires the perception of rhythm and beat which often lead to spontaneous movements (Grahn & Brett, 2007; Grahn & Rowe, 2009). As one can imagine, multiple brain areas including the temporal, frontal, parietal, cerebellar, motor and limbic areas are activated when listening to music (Koelsch & Siebel, 2005; Särkämö et al., 2012).

It is also recognized that music induces emotion experiences (Sloboda & Juslin, 2001). These music evoked emotions are often accompanied by physiological responses including changes in pulse, respiratory rhythm and muscle activity (Lundqvist, Carlsson, Hilmersson, & Juslin, 2009). Music can also induce the arousal of emotion, awakening both positive and negative emotions (Wendrich, Brauchle, & Staudinger, 2010). It does so by engaging

> "the entire limbic/paralimbic system, including structures such as the amygdala, hippocampus, nucleus accumbens, ventral tegmental area, anterior cingulate, and the

orbitofrontal cortex, which are associated with experiencing emotions, pleasure, and reward" (Särkämö et al., 2012).

One of the pathways of the limbic system is the reward system. An important structure involved in this reward system is the striatum, which is a nuclei part of the basal ganglia (Kandel, Schwartz, Jessell, Siegelbaum, & Hudspeth, 2000). Interestingly, functional MRI studies have demonstrated that the pleasure induced when listening to music was associated with the release of dopamine in this specific area of the brain (Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011). Another important component of the reward system relies on the endogenous opioid mechanisms (Chanda & Levitin, 2013). This mechanism may also explain the results of a recent meta-analysis published in the Lancet which showed that the use of music reduced post-operative pain and use of analgesia (Hole, Hirsch, Ball, & Meads, 2015). Nonetheless, the endogenous opioid mechanism is also important in terms of emotional regulation. In fact, a study recently published demonstrated that the use of naltrexone, an opioid antagonist, attenuated emotions induced by music (Mallik, Chanda, & Levitin, 2017). This finding therefore suggests that endogenous opioids also have an important role in the regulation of music-induced emotions.

There is also evidence that the use of music can reduce anxiety. It is suggested that this effect is modulated via the hypothalamic-pituitary-adrenal axis. This axis modulates multiple systems including the thyroid gland, adrenal gland, sex hormones and water balance of the human body (Chrousos, 1995). Music may decrease the levels of two markers of this axis, namely cortisol and ß-endorphins (Chanda & Levitin, 2013). In fact, it has been already demonstrated that listening to relaxing music decreased the salivary cortisol levels faster than listening to silence following a stressor (Khalfa, Bella, Roy, Peretz, & Lupien, 2003). Similarly, a randomized controlled trial found that music used in the operative setting significantly decreased the serum cortisol in participants, when compared to a control group which was listening to a non-musical placebo stimulus (Koelsch et al., 2011).

Music also brings forth an element of social affiliation. Multiple studies have demonstrated that music improves communication skills. One of the proposed mechanisms of improved communication skills is via an augmentation of the neural processing of speech. In fact, there is a significant overlap between the brain networks involved with speech and music (Patel, 2011). Music training, on the other hand, increases neuroplasticity of the auditory processing networks which is associated with improved listening skills (Kraus & White-Schwoch, 2017). Moreover, music listening increases interpersonal bonding and relationships (Welch, Himonides, Saunders, Papageorgi, & Sarazin, 2014). In fact, not only can music listening promote empathy and pro-social behaviour (Vuoskoski, Clarke, & DeNora, 2017), but doing musical activities as a group leads to a collective engagement (Cross, Laurence, & Rabinowitch, 2012). It has been hypothesized that oxytocin, a hormone released by the posterior pituitary (Kandel et al., 2000) could facilitate this social effect of music. This theory however appears to be controversial as different studies have reported conflicting results (Grape, Sandgren, Hansson, Ericson, & Theorell, 2002; Nilsson, 2009; Riedl, Javor, Gefen, Felten, & Reuter, 2017).

The hospitalized geriatric population often has multiple comorbidities, mobility issues, cognitive disorders, polypharmacy as well as specific emotional needs which can all lead to functional decline (Covinsky et al., 2003; Kernick, Chew-Graham, & O'Flynn, 2017). Due to those limitations, recreational activities offered to this population need to be adapted (Kolanowski, Fick, & Buettner, 2009). An interesting recreational activity to offer is music as it can potentially improve positive emotions, well-being, anxiety, pleasure and communication skills. Due to the needs and limitations of this population, music listening sessions, as opposed to music making sessions (group signing for example), represent an appropriate and adapted option.

1.3 Music in geriatric patients

Current knowledge on the neural basis of music has been mostly studied in young healthy participants. Therefore, one could question whether the same effects would be seen in a geriatric population. For example, when considering emotional arousal, geriatric patients sometimes suffer from neurodegenerative diseases which can alter the dopaminergic system (including Parkinson's disease and Lewy-body dementia). Also, the geriatric population often presents polypharmacy with the use of anti-dopaminergic medications (namely antipsychotics) which can also interfere with the dopaminergic system (Aarsland, 2016; Reese, Thiel, & Cocker, 2016). Despite these facts, geriatric patients, including those affected by major neurocognitive disorders, are still able to recognize musical emotions (Samson, Dellacherie, & Platel, 2009; Särkämö et al., 2012; Schall, Haberstroh, & Pantel, 2015). Not only are geriatric patients able to recognize emotions, they also express more positive emotions upon exposure to music (Schall et al., 2015; Van der Vleuten, Visser, & Meeuwesen, 2012; Vasionyte & Madison, 2013).

Music can reduce anxiety by decreasing cortisol levels. However, cortisol levels are rarely reliable in the elderly patients as they may be influenced by multiple factors: medical conditions (for example depression, hypothyroidism and liver disease), medications and age, among others (Ceccato et al., 2015; Garland & Zis, 1989; Schlechte & Coffman, 1985). Nevertheless, music can reduce anxiety in the elderly (Guetin et al., 2009; Richards et al., 2007). Moreover, music can reduce pain, improve quality of life and reduce depressive symptoms

(Cooke, Moyle, Shum, Harrison, & Murfield, 2010; Särkämö et al., 2014; Van der Vleuten et al., 2012; Werner, Wosch, & Gold, 2017).

Music enjoyment seems even possible in patients with major neurocognitive disorder, like Alzheimer's disease (Cuddy, Sikka, & Vanstone, 2015). Musical interventions including signing and music listening may also improve cognition, in particular spatial and temporal orientation, episodic memory and working memory (Särkämö et al., 2014). Moreover, there is evidence supporting the use of music in the management of Behavioral and Psychological Symptoms of Dementia (BPSD). The pharmacological options for the treatment of BPSD mainly involve the use of antipsychotics. Unfortunately, their limited benefits as well as their poor safety profile, including a higher risk of cerebrovascular event, mortality, and extrapyramidal side-effects often limit their use (Ballard, Creese, Corbett, & Aarsland, 2011; Ballard & Howard, 2006; Maust et al., 2015; Ray et al., 2001). Music, on the other hand, is a non-invasive intervention with no adverse effects which has been shown to significantly improve these neuropsychiatric symptoms in geriatric patients namely agitation, anxiety and depression (Hsu, Flowerdew, Parker, Fachner, & Odell-Miller, 2015; Ueda, Suzukamo, Sato, & Izumi, 2013; Vink et al., 2013).

In summary, there is increasing evidence that music represents an easy to implement non-pharmacological intervention in geriatric inpatients. Nevertheless, very few studies have been conducted with this population and even less so in the hospital environment. There is a need to further explore the effect of music on short-stay geriatric units.

Since October 2014, live music sessions have been organized on the Geriatric Assessment Unit (GAU) at Saint-Mary's hospital center in Montreal. Volunteer musicians have been providing an average of four one-hour music sessions per week. Most of these volunteers/musicians are McGill University students playing the piano, guitar, saxophone, and violin, or singing. On average, four to six patients per night have attended these mini-concerts on a voluntary basis. By doing a chart review, we retrospectively collected information about the patients admitted to the GAU between October 2014 and May 2016 (Chabot, Fung, Beauchet, & Peretz, 2016). Each patient who participated in the music sessions was matched with a control patient who did not participate in the music sessions based on age, sex, cause of admission, season of admission, and living situation. We found that participation to music sessions was associated with a decreased risk of falls (please refer to the Appendix 1 for the manuscript of the study). Specifically, participation to an average of 1.5 music sessions was associated with a significantly greater change (delta) in the Morse Fall Scale score from admission to discharge. As participation in the music sessions was on a voluntary basis, the allocation of the groups (intervention vs control) was not randomized. Despite performing a matched analysis, this resulted in groups displaying an imbalance in patient characteristics and a selection bias. In addition, the fact that the music intervention occurred in the presence of volunteers and other patients, the observed effect could have been due to the socialization, rather than the intervention (i.e music) itself. Nevertheless, this prior study laid a foundation for the present study.

1.4 Music and mobility

There are, to our knowledge, no other study than our retrospective study (Chabot et al, 2016), which suggests an effect of music interventions on health improvement outcomes, including lower risk of fall, on a short-stay geriatric ward. It is also uncommon to use *live* music as an intervention despite the fact that live music induces higher and more immediate levels of engagement as compared to recorded music (Holmes, Knights, Dean, Hodkinson, & Hopkins, 2006). Therefore, here, we maintained the presentation of mini-concerts provided by a musician in the GAU. Furthermore, to better understand the possible link between music interventions and mobility (or lower risk of falls), we performed a prospective randomized controlled trial.

Mobility is a very important aspect of geriatric care. Gait speed is a well-known marker of frailty and of adverse outcomes in the geriatric population (Van Kan et al., 2009). In particular, a low gait speed is associated with an increase in mortality (Studenski et al., 2011) while an improvement in usual gait speed predicts a substantial reduction in mortality (Hardy, Perera, Roumani, Chandler, & Studenski, 2007). Gait instability has also been identified as a marker of gait variability and is a fall predictor (Beauchet et al., 2009). Based on our prior results (Chabot et al., 2016) we predict that music intervention may improve gait and mobility.

Another possible link between music and gait can be found in rhythm. It has been shown that the rhythmic component of music combined with physical exercise can improve gait variability (Trombetti et al., 2011). This effect was previously observed in older community dwellers as a music-based intervention significantly improved gait and balance stability compared to control groups (Brown & de Bruin, 2011; Trombetti et al., 2011). Therefore, music listening may directly influence mobility by a process of entrainment.

Another potential mechanism by which music may affect mobility is via the effect of a mood enhancer. Music is a well-known procedure for inducing positive emotions (Ostir, Markides, Black, & Goodwin, 2000; Wendrich et al., 2010) and regulating mood (Cooke et al., 2010; Tai, Wang, & Yang, 2015; Tomaino, 2013; Werner et al., 2017). On the other hand, negative affects such as those characterizing depression are associated with a significant risk factor for falls (Launay et al., 2013) and the treatment of depression is known to reduce falls

(Gillespie et al., 2012). It can therefore be intuited that a musical intervention may indirectly improve mobility via improvement of positive mood.

Finally, it is well-known in geriatric patients that cognitive disorders significantly impair communication behaviors (Bayles, 2003). Music has a role in improving communication behavior. In fact, it has previously been shown that music can improve eye contact, participation to social activities, verbal expression, well-being as well as positive emotions (Pollack & Namazi, 1992; Schall et al., 2015).

1.5 Objectives and hypotheses

We conducted a prospective, open-labelled, randomized controlled clinical trial with two parallel groups design which assessed the change in mobility measures, emotions and communication skills of patients admitted to a GAU. The patients were randomly assigned to an intervention group or a control group. The intervention group attended a live music concert while the control group participated in a documentary-watching session. The choice of a television-watching session as a control condition was motivated by offering a similar opportunity to socialize as the music session.

The primary objective of this study was to determine if the participation to a live music concert improved mobility when compared to the control group. The measures for mobility were the Timed Up and Go (TUG) and the gait speed.

The second objective of this study was to determine if patients participating to the music session exhibited an increase/improvement in their positive emotions and their communication skills as compared to the control group. The measures for emotional experience were taken with the Visual Analog Mood Scale (VAMS) and the Observed Emotional Rating Scale (OERS). The advantage of the VAMS is that it places minimal cognitive and linguistic demands on the participants, making it an appropriate instrument for the geriatric population (Stern, 1997). The VAMS is a self-evaluation scale which has been successfully used with patients suffering from dementia (Temple et al., 2004). The OERS relies on others' evaluation and was developed to assess the emotions in older people living with Alzheimer's disease by direct observation of facial expression, body movement, and other cues which do not depend on self-reporting (Lawton, Van Haitsma, & Klapper, 1996). Finally, the Communication Behavior in Dementia (CODEM) instrument was also used to measure the communication skills of the patients.

We hypothesized that music would improve gait variability in line with our previous study (Chabot et al., 2016) and be mediated by an increase in positive emotions. We also hypothesized that music as well as positive emotions (and less negative emotions) would improve communication skills.

In order to test our hypotheses, we aimed to recruit at least 30 participants to perform a feasibility study. To our knowledge, this is the first randomized controlled study looking at the impact of music on an acute geriatric ward.

2. Methodology

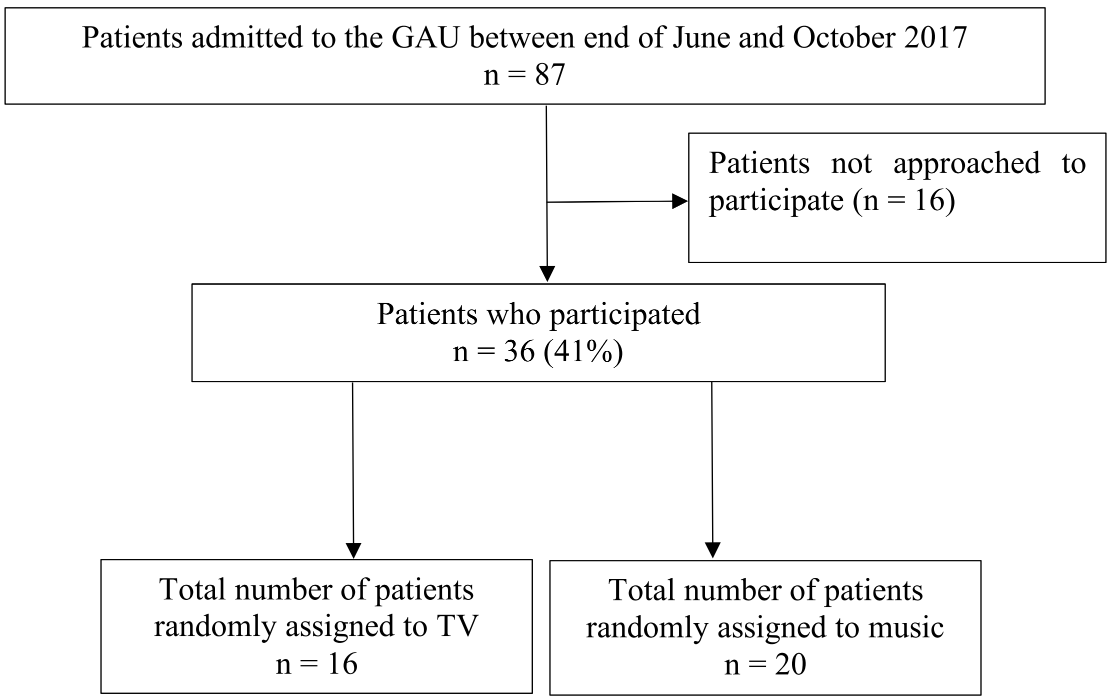
2.1 Participants

The participants were inpatients who were admitted to the GAU of St. Mary's Hospital Center (Montreal, Quebec, Canada) between the end of June 2017 and October 2017. Over the 12 weeks of the study, 87 patients were admitted to the GAU and 71 of them were approached to participate in the study.

All patients were met by Dr. Julia Chabot (principal investigator). The exclusion criteria were patients who were medically unstable, patients who exhibited potentially dangerous behavior (unpredictable agitation for example), and patients who had already participated in a music session prior to the initiation of this study (two patients). Participants who were considered to be apt as per their admitting physician and who wished to participate (following a detailed explanation) were then asked to read and sign an informed consent form. For participants who were considered to be inapt to consent, but who wished to participate in the study, an informed assent was obtained from the patient and an informed consent was obtained from the legal representative of the patient. If there were no legal representative, a reliable caregiver (i.e. usually a family member assisting in decision making for medical issues) was contacted.

Out of the 87 patients, 39 were interested in participating and signed the consent form. A total of 16 patients were not invited to participate in the study because their admission stay was too short to allow them to participate to a session (for example, some patients were admitted only over the week-end when there were no sessions). Various circumstances, including acute medical status, discharge from the hospital and withdrawal from the study, further prevented three patients from participating. Thus, a total of 36 patients participated in the study. They were randomly assigned to the music group (n = 20) and to the control group (television group; n = 16; see Figure 1). Patients who refused to participate in the study were still allowed to attend the music and/or television sessions.

Figure 1. Flow diagram of participants' enrolment



Multiple co-variables were collected including age, sex, place of living (home vs institution) upon admission and discharge, the cause of admission categorized into gait difficulties (including falls and fractures), neuropsychiatric disorders (including dementia, delirium, and behavioral disorders), acute organ failure (cardiac, respiratory, digestive, renal…) and social issues (i.e.; absence of acute medical issue combined with an inability to stay in their place of living or increased use of formal and/or informal home and social services), MMSE

(Mini-Mental State Examination) score, number of therapeutic classes taken daily upon admission, use of psychoactive drugs including benzodiazepines, antidepressants and neuroleptics (antipsychotics) upon admission, mobility upon admission (need for cane or walker), complications during the hospital stay (falls, delirium, acute organ decompensation, and behavioural problems), and the Morse Fall Scale upon admission. Table 1 shows the patient characteristics for each group. There were no significant differences in patient characteristics between the two groups.

Table 1 : Characteristics of the participants in the music and TV groups

	Music group (n = 20)	Control group (n = 16)	p-Value*
Age in years, mean (SD)	84.3 (7.5)	85.0 (8.2)	.78
Female, n	14	11	.94
Living at home prior to admission†, n	15	11	. 68
Reason for admission, n			
Mobility disorders‡	9	10	
Neuropsychiatric disorders‖	6	4	.69
Organ failure§	4	3	
Social issues**	1	0	
MMSE score (/30), mean (SD)	24.0 (4.2)	21.5 (5.1)	.14
Therapeutic classes daily taken			
Mean upon admission (SD)	8.8 (3.4)	7.9 (4.1)	.13
Use of psychoactive drugs¶, n			
Upon admission	9	8	. 77
Morse Fall Scale (/125), mean (SD)	64.2 (22.6)	65.9 (23.3)	. 83
Complications during hospital stay	3	4	.45
Assistance for mobility††	14	12	.74

SD: standard deviation
MMSE: Mini Mental Status examination
* = Comparison between intervention and control group based on unpaired *t*-test or Chi-square test, as appropriate; significant *p* values (i.e.; ≤0.05); † = Versus institution prior to admission; ‡ = Defined as gait and/or balance disorders and/or falls (unintentionally coming to rest on the ground, floor, or other lower level) ; || = Defined as a neurocognitive disorder (dementia), delirium or behavioral disorders , § = Defined as congestive heart failure, chronic lung disease, chronic kidney disease or cirrhosis, ** = absence of acute medical issue combined with an inability to stay in their place of living or increased use of formal and/or informal home and social services, ¶ = Antidepressants, benzodiazepines or neuroleptics, †† = Defined as the use of a mobility aid (cane, walker…).

The medical team deemed that it would have been unsafe for 19 of the patients to undergo mobility assessments (Timed-Up-And-Go and gait speed). These patients were included in the study, but only emotional and communication measures were collected for them.

For the purpose of this project, only the first participation in a session (music or television) was considered in the analysis. In other words, after participating in one session, no further data was collected for research purposes. However, patients who had already participated were allowed to attend sessions of their choice (i.e. patients who were in the television group were allowed to attend the music or television sessions and vice-versa). Of the 20 patients in the music group, eight continued to attend the music sessions after their initial participation and four attended a television session. Of the 16 patients in the television group, one participated again to a television session, but seven participated to a music session afterwards.

2.2 Research Design

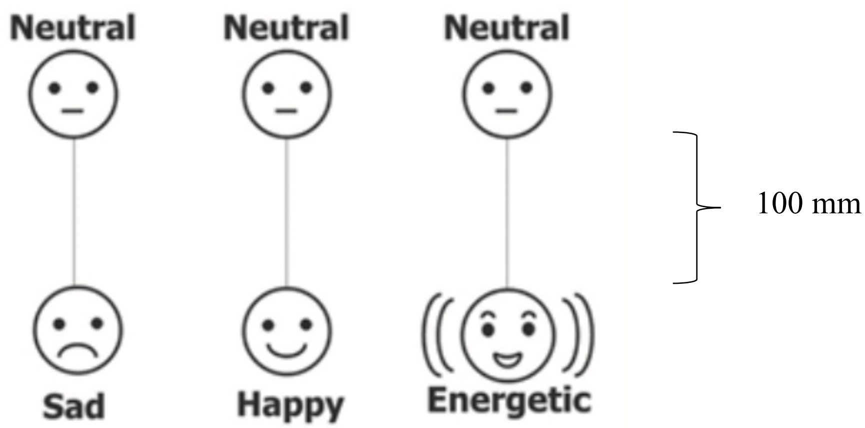
The design was a prospective, randomized controlled clinical trial with two parallel groups which was open-labelled (the participants were not blinded to the group they were randomized to). Patients who accepted to participate in this study were randomized into two different groups: an intervention group (attendance to a live music session) and a control group (attendance to a television session). Four times a week, participants were randomly assigned to the music group or the TV group. The randomization was done via an Excel file (random allocation).

2.3 Material and procedure

The mobility measures included two different tests: the Timed Up and Go and the gait speed assessment. The Timed Up and Go assessment is a standardized test (Podsiadlo & Richardson, 1991) in which participants are asked to stand up from a chair, walk 3 meters, turn back, walk 3 meters again and sit down. The participants are asked to do so in a well-lit environment, using their mobility aid if needed (cane or walker). A duration of less than 14 seconds is considered as normal whereas a longer duration of 14-20 seconds represents a mild mobility impairment, and a duration of more than 30 seconds represents an important mobility impairment (Podsiadlo & Richardson, 1991). In order to measure their gait speed, the participants were again asked to walk over 3 meters at their comfortable pace in a quiet, well-lit corridor wearing their own footwear. In order to avoid acceleration and deceleration effects, participants began walking one meter before the “start line” and walked one meter beyond the “finish line”. “Normal” gait speed varies between 0.90 m/s and 1.30 m/s in elderly community-dwellers (Graham, Fisher, Bergés, Kuo, & Ostir, 2010).

In order to assess the patients’ mood, the Visual Analog Mood Scale (VAMS) was used (Stern, 1997). It consists in the evaluation of two positive emotions (happy and energetic) and six negative emotions (afraid, confused, sad, angry, tired and tense) with the use of schematic faces connected by a 100 millimetres vertical line. In Figure 2, examples of three emotions (sad, happy and energetic) response scales of the VAMS are presented. The top picture always depicts a neutral mood face. The patients are asked to draw a line across the 100-mm vertical line to represent their current mood on the eight dimensions. The calculated score for each of those responses is equal to the distance in millimetres from the neutral face.

Figure 2. Examples of three scales of the VAMS (Visual Analog Mood Scale)



The Observed Emotion Rating Scale (OERS; (Lawton et al., 1996) consists of an evaluation scale for two positive emotions (pleasure and general alertness) and three negative emotions (anger, anxiety/fear, and sadness). The observer rates each emotion on a scale from 1 to 5, with 1 meaning never, 2 present for less than 16 seconds, 3 for more than 16 but less than 59 seconds, 4 for 1-4 minutes, and 5 for more than 5 minutes). These measures were taken over a ten-minute period by two independent raters who watched the video recordings of the session for each patient. Reported κ values for interrater reliability range from .29 to .66 (Lawton, Van Haitsma, & Klapper, 1999). Even if the reported κ is relatively low, the scale is considered appropriate for a geriatric population (Schall et al., 2015). It was therefore decided that this scale should be used for the purpose of this study (see Figure 3).

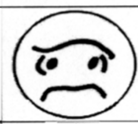
Figure 3. The Observed Emotion Rating Scale

OBSERVED EMOTION RATING SCALE

RESIDENT'S NAME ________________ UNIT: _________ OBSERVER'S NAME: __________________ DATE: TIME:

Please rate the extent or duration of each affect over a ten-minute period. Some possible signs of each emotion are listed.

If you see <u>no sign</u> of a particular feeling, rate "Never."

		7	1	2	3	4	5
		Not in view	Never	Less than 16 sec.	16-59 sec.	1-5 min.	more than 5 min.
PLEASURE Signs: Laughing; singing; smiling; kissing; stroking or gently touching other; reaching out warmly to other; responding to music (**only** counts as pleasure if in combination with another sign).							
ANGER Signs: Physical aggression; yelling; cursing; berating; shaking fist; drawing eyebrows together; clenching teeth; pursing lips; narrowing eyes; making distancing gesture.							
ANXIETY/FEAR Signs: Shrieking; repetitive calling out; restlessness; wincing/grimacing; repeated or agitated movement; line between eyebrows; lines across forehead; hand wringing; tremor; leg jiggling; rapid breathing; eyes wide; tight facial muscles.							
SADNESS Signs: Crying; frowning; eyes drooping; moaning; sighing; head in hand; eyes/head turned down and face expressionless (**only** counts as sadness if paired with another sign).							
GENERAL ALERTNESS Signs: Participating in a task; maintaining eye contact; eyes following object or person; looking around room; responding by moving or saying something; turning body or moving toward person or object.							

The Communication behavior of the patients was assessed with the Communication Behavior in Dementia (CODEM; (Kuemmel, Haberstroh, & Pantel, 2014). It is a standardized "observational communication behavior assessment" tool developed and evaluated for dementia care and social-communicative behavior. It consists of 15 different items (8 verbal and 7 non-verbal items). An example of a verbal assessment is the "patient uses words according to their meaning" and an example of a non-verbal assessment is the "patient makes eye contact". This assessment requires a 10-minute observation-period of the participant and uses a scale from 0 to 5 to quantify the communication skills of each participant, with 0 referring to a behavior that is not shown during the interaction, 1 to a behavior that is rarely seen (1-24%) during the interaction, 2 to a behavior shown in less than half (25-49%) of the interaction, 3 to a behavior shown in more than half (51-75%) of the interaction, 4 to a behavior shown in nearly all (76-99%) the interaction, and 5 to a behavior which is always shown (100%) during the interaction. These ratings have an excellent interrater reliability (mean $\kappa = .79$; intra-class correlation = .91) and internal consistency (Cronbach's $\alpha = .95$) (Kuemmel et al., 2014). A copy of this scale can be found in the Appendix 2.

We considered here five change measures: the change in the Timed Up an Go test, the change in gait speed, the change in self-assessed emotions on the Visual Analog Mood Scale, the change in observed emotion on the Observed Emotional Rating Scale, and the change in the communication behaviour measured with the CODEM. In order to measure the changes for the Timed Up and Go, the gait speed and the change in the Visual Analog Mood Scale, the pre-test measures were subtracted from the post-test measures. In order to measure the changes for the Observed Emotional Rating Scale and the Communication Behavior in Dementia (CODEM) the measures from the first 10 minutes of the videotaped session analysis were subtracted from the measures of the last 10 minutes of the videotaped session analysis.

These measures were taken either before, during or after a single music or television session, which took place in the family room and conference room of the GAU. These two rooms are similar in size, have windows and are at a similar distance, around 20 meters, from the nursing station. Between three to eight patients participated to each session in the evenings.

The music group attended a 30-minute live mini-concert performed by one volunteer musician. Different musicians played on different evenings. The musical styles varied between classical and popular music. The control group watched a 30-minute documentary on a TV screen in the presence of a volunteer. Two different documentaries were shown alternatively.

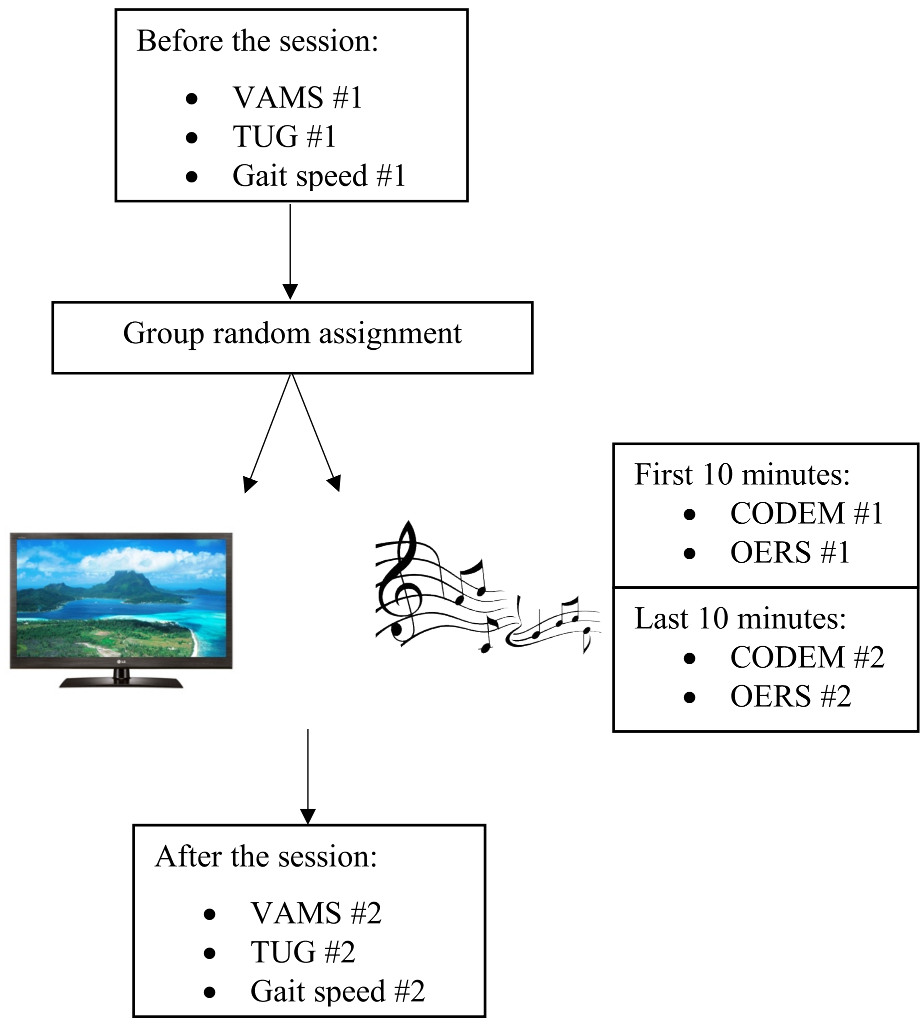
The first one was *Microcosmos,* (Nuridsany & Pérennou, 1996) which captures the beauty of the tiny flora and fauna living in the herbs and soil. The second one was *Oceans* (Perrin & Cluzaud, 2010), which reveals the nature of oceans and sea creatures. For both documentaries, occasional narration was present and the musical background was not omnipresent (less than 45% of the total duration of the session). The choice of language (English or French) was based on the patients' preferences.

Prior to the start of the music or television session, participants underwent a mobility assessment (TUG and gait speed) and filled a Visual Analog Mood Scale. These measures were taken by a trained research assistant just before the randomization process. Therefore, neither the patient nor the research assistant knew to which group the patient would be assigned to. Afterwards, the patients were brought by the hospital staff to the music or TV session according to the assignment sheet which was prepared by the principal investigator. Each session was videotaped on GoPro cameras which were placed on a tripod mount set.

At the end of the session, the patients were brought back to their respective rooms. Within a few minutes, they again underwent a mobility assessment and filled the Visual Analog Mood Scale. These measures were collected by the same research assistant who was again blind to the attributed group. The patients were instructed not to reveal to the research assistant which session they participated in. However, four patients (two from the music and two from the TV group) did not follow those instructions.

The videotaped sessions were evaluated independently by two assistants who filled two CODEM and two OERS per patient: the first one was filled for the first 10 minutes of the session and the second one was filled for the last 10 minutes of the session. The assistants were trained prior to the start of the study in order to promote consistency in the ratings. Furthermore, during the study, the κ was measured twice and retraining was promptly undertaken in case of discrepancies between the two reviewers. This happened once during the 12-week duration of the study. A diagram of the methodology of the study is presented in Figure 4.

Figure 4. Schematic flow of the methodology of the study



2.4 Ethics

The study was conducted in accordance with the ethical standards set forth in the Helsinki Declaration (1983). The study was approved by the research ethics committee of St. Mary's Hospital Center under project 14-31B as well as the "*Comité d'éthique de la recherche en arts et en sciences*" (CÉRAS) under project 2017-18-139-D. The study was registered at clinicaltrials.gov under NCT03328793.

3. Results

3.1 Participants' mobility

Prior to the intervention, only 12 patients from the music intervention group and 5 patients from the control group were able to complete the mobility assessment.

In the music group, the mean of the first assessment by the Up and Go test was 24.28 seconds (SD = 11.01) prior to the session; it was 26.03 seconds (SD = 11.16) after the session. In the television group, pre-session Times Up and Go was 20.79 seconds (SD = 12.32) and was 29.99 seconds (SD = 16.64) after the session. Durations were highly variable across patients (range: 7.15 and 49.87 seconds).

Regarding the gait speed, the mean of the pre-test measure in the music group was 0.55 meters/second (SD = 0.29) and the post-test measure was 0.59 meters/second (SD = 0.23). In the television group, those measures were respectively 0.70 meters/second (SD = 0.46) and 0.59 meters/second (SD = 0.25). Again, the gait speeds were very variable as they ranged from 0.19 and 1.46 meters/second.

Due to the small number of patients and the variability of the measure, we did not consider these data any further.

3.2 Participants' emotions and communication

The changes in self-rated emotions after vs before the session followed a normal sampling distribution for the *happy* emotion only. The change was calculated by subtracting the levels of happiness indicated by the participants before the session from the levels of happiness after the session, as measured by the distance in millimeters from the neutral face. Accordingly, an independent sample t-tests was applied to the change in happiness in the music and television group. Participants in the music session reported a higher increase in happiness (M= 28.5, SD= 35.74) than the participants in the television session (M= -11.7, SD= 56.63). This difference (-40.23), BCa 95% CI [-70.3, -10.2] is significant t(33) = -2.7, p = 0.01 with a large-size effect, d = 0.78, indicating a significant increase in reported happiness after the music session relative to the television session.

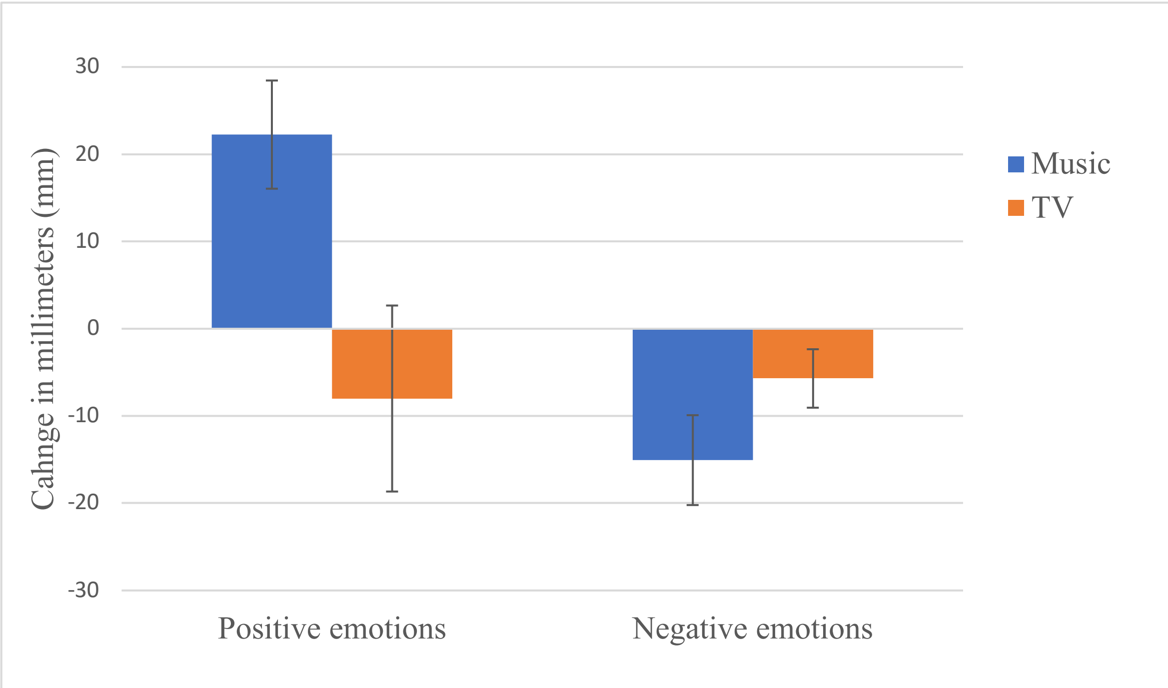
For the other changes in the self-rated emotions, non-parametric Mann-Whitney U-tests were performed. Only the changes in the emotion *energetic* were close to statistical significance in the music session (median = 16.0) when compared to the patients of the television group (median = -4.3), U = 202.00, z = 1.73, p= 0.09, with an effect size r = 0.29. Table 2 summarizes the mean ratings obtained for each emotion obtained with the Visual Analog Mood Scale before and after the sessions.

Table 2 : Average level (in mm) of self-reported emotions with the VAMS before and after the sessions

Emotion	Music Group		Television Group	
	Before the session M (SD)	After the session M (SD)	Before the session M (SD)	After the session M (SD)
Happy	44.0 (38.0)	72.5 (32.5)	50.1 (43.1)	38.3 (43.0)
Energetic	31.4 (35.1)	47.4 (33.3)	41.3 (36.5)	37.0 (42.5)
Afraid	27.0 (39.6)	13.1 (25.6)	19.1 (35.2)	15.6 (34.7)
Angry	17.7 (33.4)	10.3 (23.9)	12.0 (28.3)	18.6 (35.5)
Confused	16.6 (24.5)	10.7 (20.7)	23.2 (40.1)	24.3 (38.9)
Sad	31.8 (38.0)	14.7 (27.8)	43.6 (38.7)	24.9 (38.6)
Tense	38.2 (38.3)	23.2 (33.7)	28.9 (37.2)	38.3 (40.1)
Tired	60.4 (35.5)	29.2 (33.9)	53.9 (46.5)	24.8 (41.0)

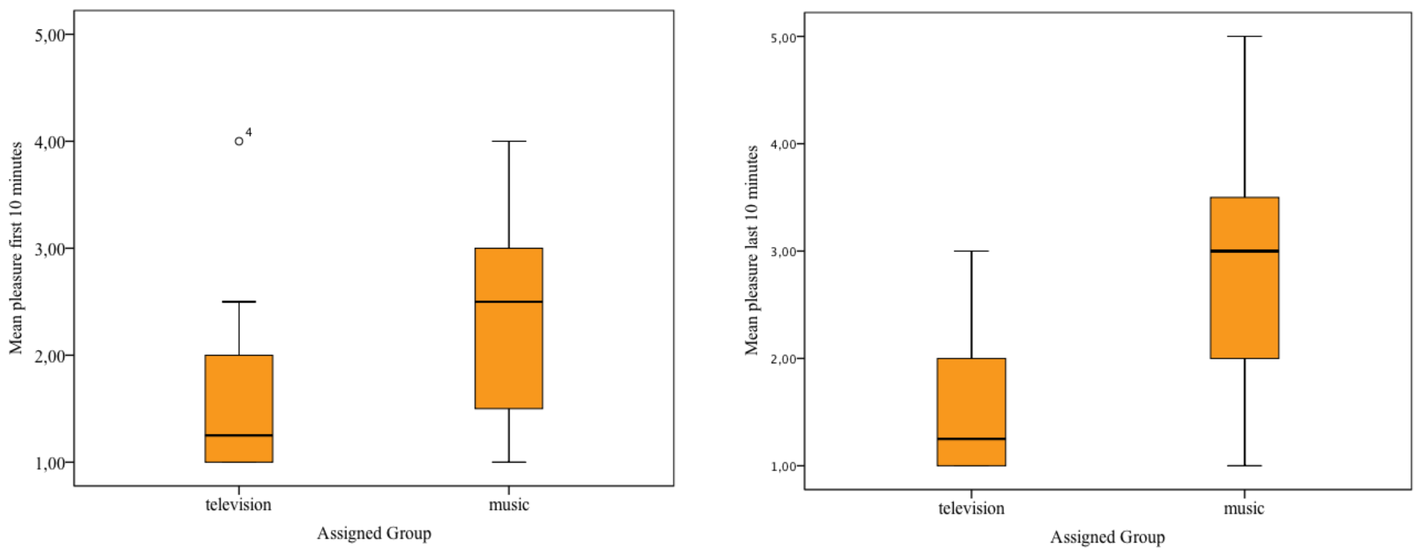
In order to better capture the changes observed in self-reported emotions, we averaged the change (after session minus before session) in ratings for the two positive emotions (happiness and energy) and the change in the ratings for the six negative emotions for each participant (Figure 5). First, in order to evaluate if there was a measurable change, the changes were compared to 0. A reduction of negative emotions and an increase of positive emotions were observed in the music group only, with $t(20) = -2.93$, $p = 0.009$; C.I.: -25.84 to -4.29 and ($t(20) = 3.59$, $p = 0.002$; C.I.: 9.27 to 35.23, respectively. Changes in negative and positive emotions did not differ from 0 in the television group ($t(15) = -1.70$, $p = 0.111$; $t(15) = -0.75$, $p = 0.465$). As can be seen in Figure 5, there was little change in emotional self-evaluation in the television group whereas after the music session, participants expressed more positive emotions and less negative emotions. Note that this modulation of self-rated emotions in the music group compared to the television group holds when non-subtracted scores are considered.

Figure 5. Change in positive and negative self-rated emotions in each group



The change obtained in self-rated emotions after the music session is expected to be objectively observed. This was the case: the results obtained with the Observed Emotional Rating Scale (OERS) by the two research assistants is consistent with the self-reports. The overall weighted κ obtained on the OERS was 0.45 which corresponds to a moderate strength of agreement among the two judges. The agreement was particularly high for the *pleasure* component of the OERS with a κ of 0.70 which corresponds to a good strength of agreement (Landis & Koch, 1977). Out of the five emotions assessed with the OERS, only the ratings for pleasure followed a normal distribution assumption. Therefore, a mixed ANOVA with a 2 x 2 design was performed on pleasure ratings only, using the score averaged across the two judges as the dependent measure during the first 10 minutes and the last 10 minutes of the session for each patient in each group (Figure 6). The main effect of group was significant ($F(1,29) = 9.97$, $p = 0.004$) and there was no interaction between Time of observation and Group ($F(1, 29) = 1.55$, $p = 0.224$). As can be seen in Figure 6, the music group displayed more pleasure than the television group both at the beginning and at the end of the session.

Figure 6. Boxplot for observation of pleasure in patients during the first (left box) and last (right box) 10 minutes of the music and television session



Regarding the other emotions of the Observed Emotional Rating Scale, namely anger, anxiety/fear, sadness and general alertness, we note that negative emotions were almost never observed in either group. In contrast, both groups displayed high general alertness. Please refer to the Appendix 3 for the mean ratings given by the two judges with the Observed Emotional Rating Scale for the first and last 10 minutes of the sessions.

In order to assess the relationships between self-reported *happiness* (on the Visual Analog Mood Scale) and observed *pleasure* (on the Observed Emotional Rating Scale), a

Pearson correlation coefficient was computed on self-rated happiness after the session and observed pleasure as averaged across the two judges. It was found to be significant [r = .52, n = 17, p = .031; Figure 7] in the participants of the music session group. However, this was not the case for the television group [r = -.05, n = 13, p = .874; Figure 8].

Figure 7. Self-rated happiness expressed after the session as a function of averaged score on displayed pleasure in the music group

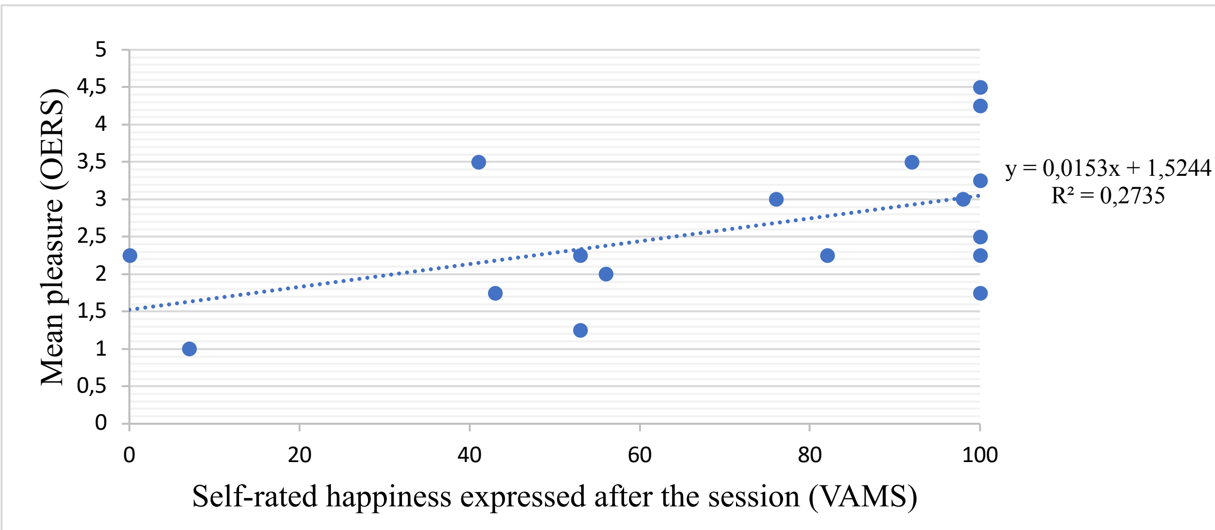
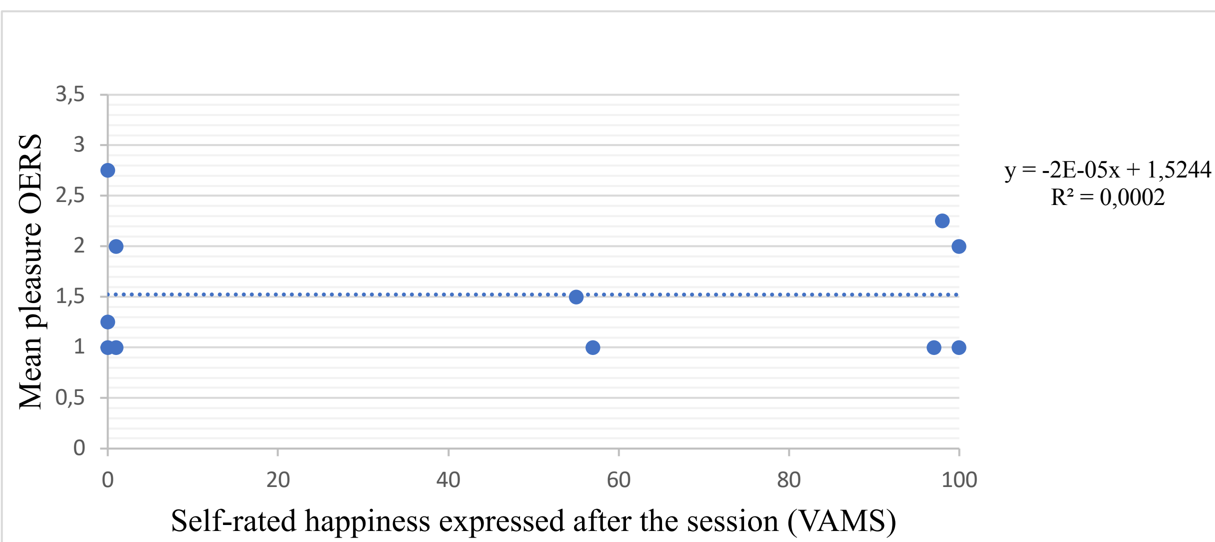


Figure 8. Self-rated happiness expressed after the session as a function of average score on displayed pleasure in the television group



The communication skills of the patients were assessed with the Communication Behavior in Dementia (CODEM). The average κ (corresponding to the inter-rater agreement of the two research assistants analyzing the videotapes) was low with 0.320. This only corresponds to a fair strength of agreement (Landis & Koch, 1977). For this reason, we did not pursue further the analyses with this scale.

Discussion

In this randomized control trial, we showed that patients admitted to a geriatric care unit who participated in a music listening session compared to a television watching session reported enhanced happiness and displayed increased pleasure. The correlation between these two measures was statistically significant. It was also found that patients who participated in a music listening session demonstrated increased levels of positive emotions and decreased levels of negative emotions after their participation compared to patients in the television group. Thus, attending a single music concert was sufficient to improve mood in hospitalized elderly people.

These results are in line with one prediction for conducting this study. Indeed, the participants who were assigned to the music session showed higher levels of change in reported happiness on the Visual Assessment Mood Scale questionnaire, compared to the participants in the television session. On the other hand, the music and television sessions were also videotaped and analysed by two independent research assistants. The research assistants analysed the first and last 10 minutes of the session. Although there was no significant change in the level of observed *pleasure* (between the first and last 10 minutes of the session) during the musical intervention, as compared to the control group, there was a significant difference between the two groups at both measured times. In other words, the patients subjected to the musical intervention exhibited more pleasure overall when compared to the patients of the television group. Interestingly, there was a positive correlation between the mean reported happiness of the patients (on the VAMS) and the mean pleasure observed by the research assistants. Putting it differently, the level of happiness which was reported by the patients in the music group correlated with the levels of pleasure which were observed by the two research assistants who reviewed the videotapes. This finding is interesting for three main reasons.

The first reason is that this suggests that the Visual Analog Mood Scale is likely an appropriate scale to help patient self-report their emotions. This is an important finding considering that not all individuals are aware or able to report their transient emotional states (Mauss & Robinson, 2009) and that hospitalized geriatric patients often have a negative perception of themselves (Blazer & Houpt, 1979; Trentini et al., 2012).

The second reason is that the positive effect of music on patients' emotions (positive emotions and pleasure) takes place within only a few minutes of music listening and appears to last for the duration of the whole session (30 minutes). The "immediate" effect of music in inducing these positive emotions has already been shown. For example, it was also demonstrated that brief musical stimulations (three-minutes clips) can change physiological emotional arousal (changes in heart rate, body temperature…) and predict the reported pleasure of the patients (Salimpoor, Benovoy, Longo, Cooperstock, & Zatorre, 2009). In other words, pleasurable music appears to stimulate the sympathetic nervous system during music listening very quickly. It is possible that live music may have contributed to the "immediacy" of this effect, as it is known that live performances generate higher and more immediate levels of engagement (Holmes et al., 2006).

The third reason to be considered pertains to the challenge we face while treating depression in the elderly population. In fact, multiple things including the side-effect profile of antidepressants as well as the medical comorbidities affecting patients have to be considered prior to initiation of treatment. Furthermore, recent evidence suggests that, when prescribed antidepressants, geriatric populations may necessitate 10 to 12 weeks of treatment before experiencing any onset of action (Nelson, Delucchi, & Schneider, 2008). Music may therefore represent an intervention that improve the mood of geriatric inpatients within a few minutes. It is however impossible to determine the duration of the effect of a musical intervention in the present study. In the future, it would be interesting to clarify if the effect of such a musical intervention will last over time and how often the intervention must be offered to observe long-term effects.

To our knowledge, this is the first randomized controlled trial specifically looking at the effects of music involving patients from an acute geriatric ward. Our study has multiple strengths. First of all, the methodology of the study was robust as an *a priori* hypothesis was formulated and we used reference design to examine the effect of an intervention (i.e., randomized controlled trial). This eliminates selection bias in the group attribution. Moreover, the randomization process was successful as the participants' characteristics were similar among the two groups and could not account for the observed differences in response to the intervention. Secondly, the data collection for the Timed Up and Go test, the gait speed assessment and the Visual Assessment Mood Scale questionnaire were all done by a research assistant who was blind to the group attribution of the patients. Although the research assistants performing the analysis of the videotaped sessions could not be blind to the type of group concerned, their respective analyses were done independently and their overall level of agreement for the OERS was fair (κ of 0.450) (Landis & Koch, 1977). Finally, this study indicates a positive impact of mini-concerts of live music in geriatric inpatients, thereby favouring a *Senior-Friendly Hospital* Approach.

The primary objective of this study was to assess if a musical intervention would have an effect on the mobility of geriatric inpatients admitted to a short-stay Geriatric Unit. Out of the 36 patients who participated in this research, only 17 patients were able to undergo a mobility assessment (12 in the intervention group and 5 in the control group). The low number of patients who were able to undergo such an assessment can be explained by a combination of factors. First, the majority of the patients who were included in this study were initially admitted due to mobility disorders (n = 19, 52.8%). In other words, the majority of the patients who were admitted to the GAU were admitted either due to a fall, musculoskeletal injury, fracture or gait disorder. Thus, upon admission to the GAU, these patients may not have been able to perform a Timed Up and Go test or to undergo a gait speed assessment in the context of an active medical issue (i.e. uncontrolled pain, unsafe gait, medical contraindication to mobility…). Second, geriatric inpatients are very often considered frail. Frailty is usually referred to as a state of physiological vulnerability which exposes patients to adverse health, functional and social outcomes (Sternberg, Wershof Schwartz, Karunananthan, Bergman, & Mark Clarfield, 2011). Low gait speed (or poor mobility) is considered a marker of frailty (Fried et al., 2001). Although there are multiple definitions of frailty, it is commonly reported as being a disproportionate change in health status in response to an apparently small insult (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013). For example, it is possible that, in response to a hospital admission, patients can go from a mobile to an immobile status. Furthermore, our patient population may have been clinically too sick or too frail in order to undergo a mobility assessment. The ability to undergo a mobility assessment should have been an inclusion criteria in the present study. However, mobility can vary significantly during the same day in elderly patients due to medical conditions including orthostatic hypotension and Parkinson's disease (Lanier, Mote, & Clay, 2011; Pahwa et al., 2006). Therefore, limiting our study to mobile patients only may have been unrealistic. In any case, the mobility assessment was likely not a convenient metric in this specific population. In other words, the assessment of the effect of music on mobility is probably non-feasible on an acute geriatric care unit.

Despite these positive results, the study has limitations. The main one is the fact that we were unable to collect enough information in order to meet our primary objective concerning mobility improvement. Additionally, we were unable to pursue analyses pertaining to the communication behavior of our patients (with the CODEM scale). It is possible that this scale was not the most appropriate to use with this patient population or in this specific situation. It is also possible that the music and television sessions did not encourage enough communication or interaction behavior, making the use of this scale difficult for the analysis of these specific activities. Another possibility is that the metrics of this instrument were too specific to assess during activities such as music listening and television watching. Also, the social behavior that patients exhibit during those sessions is subtle and the Communication Behavior in Dementia (CODEM) instrument may not have been sensitive enough. Another significant limitation is the fact that the two research assistants who reviewed the videotaped sessions could not be blind to the group attribution of the patients. Therefore, it is possible that they had a positive bias or a negative bias when analyzing the television sessions and that this is reflected in the results of the Observed Emotional Rating Scale (OERS) which were obtained. Finally, this study only evaluated the impact of attendance to only one music or one television session. A longitudinal type of design would have been interesting in order to evaluate the impact of multiple sessions over time.

In summary, we reported the results of a randomized control trial performed on a geriatric assessment unit which aimed to evaluate the impact of participation to a music listening session compared to a television watching session. Participants who were randomized to the music group reported higher levels of change of happiness and had higher levels of observed pleasure. The correlation between the two variables was statistically significant. It was also found that participants from the music session displayed a higher increase in their positive emotions as well as a more pronounced decrease in their negative emotions. To our knowledge, this was the first randomized control trial which took place on a geriatric assessment unit. In the future, it would be interesting to study if the effects which were observed last over time.

Conclusion

This study evaluated the impact of mini-concerts of life music on the mood of geriatric inpatients relative to television watching sessions. We found that attendance to a music listening intervention led to higher levels of happiness as well as higher levels of observed pleasure. Such a simple intervention represents a therapeutic approach which is free of adverse effects and inexpensive. It would be interesting to assess if the results of this study could be reproduced in other settings. Another question that could eventually be clarified would be if musical interventions continue to be beneficial over time or if the effects of music are long-lasting.

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Appendix 1

Manuscript Decreased risk of falls in patients attending music sessions on an acute geriatric ward: results from a non-randomized open-label trial

Abstract:

Background. Music has been shown to improve health, communication and quality of life. It has been suggested that music may also have an impact on gait stability and the risk of falls. Yet, few studies have exploited music in the hospital setting, and even less so in the geriatric population. Our objective was to examine the influence of music listening on the risk of falls by comparing the Morse Fall Scale (MFS) score in patients admitted to a Geriatric Assessment Unit (GAU) who attended music listening sessions and in control patients who did not attend music sessions.

Methods. This was a non-randomized open-label trial nested in a retrospective cohort study (mean follow-up 13.3 ± 6.8 days) which took place in a GAU, St. Mary's Hospital Center, Montreal. A total of 152 participants, with a mean age of 85.7 ± 6.4 years and 88.2% female. There were 61 participants in the music listening session group and 91 in the control group matched for age, sex, cause and season of admission, and living situation. One-hour music sessions were provided to the patients by volunteer musicians an average of three to four times per week. The MFS score upon admission and discharge as well as its variation (change from before to after intervention) were used as outcomes. Age, sex, living situation, reason for admission, season of admission, Mini Mental Status Examination score, number of therapeutic classes taken daily upon admission, use of psychoactive drugs upon admission and length of stay were used as covariates.

Results: The MFS score decreased significantly in the intervention group compared to the control group (p = 0.025). The multiple linear regression model showed that there was an association between the decrease of the MFS score and participation in music listening sessions (β = -19.0, p = 0.026).

Conclusion: Music listening was associated with a decreased risk of falls in patients admitted to a GAU. Further controlled research is necessary to confirm these findings and to determine the mechanisms by which music listening impacts fall risk.

Retrospectively registered study: Clinical trial registry: ClinicalTrials.gov. Registered number: NCT03348657 (November 17th, 2017).

Key words

- Music
- Fall
- Elderly

Background

Music is often used as a non-verbal means of emotional expression [1]. As communication can be impaired in the elderly due to cognitive impairment and diseases, music can be used to recreate communication between the patients and their environment [2, 3]. Music therapy has long been used to improve communication, health and quality of life. Music is also known to regulate pain, mood and anxiety levels [4-10]. In the geriatric population, music listening has been shown to decrease depressive symptoms [11-15] and neuropsychiatric symptoms such as agitation and anxiety [9, 16]. As a result, the use of music is recommended by national guidelines to control the behavioural symptoms of patients in long-term care facilities [17]. Despite the demonstrated positive benefits of music for health and behavioural outcomes, very few studies using music have been performed in the hospital environment and even fewer on short-stay geriatric units.

Older adults are the fastest-growing group of patients admitted to hospital, and the age-related burden of non-fatal health outcomes is one of the main challenges faced by hospitals. Thus, assessing and addressing the needs of the growing number of geriatric patients is necessary [18]. One of those age-related burdens is related to falls [19-21]. Falls are highly frequent in geriatric patients, particularly on short-stay geriatric units, with a prevalence of up to 30 % [20]. Falls are associated with increased length of hospital stay, high health-care costs and negative non-fatal health outcomes including multi-morbidities and related disabilities [19-23].

Previous research has shown that music may decrease the risk of falls [24, 25]. For example, it was shown that the rhythm of music, combined with physical exercise, can improve measures of gait stability [24, 26]. In older community dwellers, music-based programs have demonstrated that improvement of gait stability decreased the risk of falls [24, 25]. We therefore hypothesized that music listening may decrease the risk of falls of geriatric patients admitted to a short stay unit.

This study aimed to examine the influence of music listening on the risk of falls in patients admitted to a Geriatric Assessment Unit (GAU) by comparing the Morse Fall Scale (MFS) score for patients who attended music listening sessions and in control patients who did not attend these music sessions. To our knowledge, this is the first study to assess the effect of music listening on the risk of falls in a geriatric unit.

Methods

Participants

The participants were a convenience sample of inpatients who were admitted to the GAU of St. Mary's Hospital Center (Montreal, Quebec, Canada) between October 2014 and May 2016. The inclusion criteria were a first admission to the GAU and a length of stay between 5 and 31 days. Of the 571 inpatients admitted during the period of recruitment, 152 (26.6%) participants (mean age 85.7 ± 6.4 years, 88.2 % female) were recruited in this non-randomized open-label trial nested in a retrospective cohort study.

As participation to the music sessions was voluntary, the patients from the intervention group were matched to patients who did not attend the music sessions (control group) according to age (+/- 3 years), sex, season of admission, cause of admission, and living situation (at home or institutionalized). In total, 61 patients were included in the intervention group (music sessions) and 91 patients were included in the control group.

Assessment

The charts of the patients who were admitted to the GAU were reviewed using a systematic and standardized procedure for collection of data. Collected information included age, gender, reason for admission (mobility disorders, neuropsychiatric disorders and organ failure), living situation prior to admission, season of admission, Mini Mental Status Examination score [27] at the time of admission, number of therapeutic medication classes taken daily (excluding laxatives) upon admission and discharge, use of psychoactive drugs (i.e., benzodiazepines, antidepressants or neuroleptics) upon admission and discharge, MFS score upon admission and discharge, and length of stay.

Risk of falls

The risk of falls was measured using the Morse Fall Scale (MFS). This is a rapid and simple method to assess the probability that a patient will fall. The total score is out of 125 and includes 6 items: history of previous falls, presence of a secondary diagnosis (i.e. more than one medical diagnosis in the patient's chart), use of an ambulatory aid (none, cane, walker), presence of intravenous therapy, gait and transfers (normal, weak, impaired) and the patient's mental status (oriented towards own ability or not). The score is further divided into 3 risk levels: low risk (<25 points), medium risk (25-44 points) and high risk (≥ 45 points) [23, 28]. If a patient is classified in the medium risk category, then universal fall prevention interventions are applied (environmental modifications, and consideration regarding ambulation). However, if a patient is classified in the high risk category, then individualized fall interventions are applied in addition to universal fall prevention interventions (padded furniture, moving the patient near the nursing station, consider use of a transfer belt, etc.). At St. Mary's Hospital Center, the MFS is completed within 24 hours of admission, upon transfer to a different unit, within 48 hours following a fall, and every week. For this study, the first MFS score (upon admission) and the last MFS score (prior to discharge) were collected.

Standard Protocol Approvals, Registrations, and Participant Consents

The study was conducted in accordance with the ethical standards set forth in the Helsinki Declaration (1983). The study was approved by the Research Ethics Committee of St. Mary's Hospital Center (SMHC #14-31). As this was a retrospective study, written consent from the participants was not obtained. This study was retrospectively registered: Clinical trial registry: ClinicalTrials.gov. Registered number: NCT03348657 (November 17th, 2017).

Statistical analysis

Participants were separated into 2 groups (intervention versus control) based on whether they participated in the music listening sessions. The participants' characteristics were summarized using means and standard deviations or frequencies and percentages, as appropriate (see Table 1). For the analysis, change in the MFS score was calculated as follows: ((discharge - upon admission)/ ((discharge + upon admission)/2)) x100. Comparisons between groups were based on unpaired *t*-tests and Chi-square tests, as appropriate. Multiple linear regression was performed to examine the association between changes in MFS score (dependent variable) and participation in the music listening sessions (independent variable) adjusted for participant characteristics. *P*-values less than 0.05 were considered statistically significant. All statistical analyses were performed using SPSS (version 24.0; SPSS, Inc., Chicago, IL).

Results

Table 1 shows patient characteristics and MFS scores for each group. The intervention group had a significantly longer length of stay at the hospital ($p=0.019$). Also, more participants from the intervention group were classified as high risk for falls upon admission than from the control group ($p = 0.045$) (Table 2), and the intervention group appeared to have higher MFS scores on admission, although this difference did not reach significance ($p = 0.078$). The primary finding of this study is a significantly greater variation (reduction) in the MFS score from admission to discharge in the intervention group when compared to the control group ($p = 0.025$). Also, although this was not significant, there were fewer patients from the intervention group who were classified in the high risk category upon discharge (Table 2).

As shown in Table 3, a multiple linear regression was performed to examine the relationships between variation of the MFS score, group assignment, and patient characteristics. After adjusting for multiple participant's characteristics, a significant decrease in MFS score after the music listening sessions was found ($\beta = -19.0$ with $p = 0.026$).

Discussion

There was a significant reduction in the MFS score in the intervention group compared to the control group, indicating a decreased risk of falls after participation in the music listening sessions. Risk factors for falls in the geriatric population are multifactorial and very complex. One of those risk factors is depression. A recent meta-analysis shows that the association between falls and depression in older people has an odds ratio of 1.63 (95% CI: 1.36–1.94) [29]. Considering that music has been associated with an improvement in depressive symptoms in the geriatric population [8, 14, 30], it is possible that the musical intervention indirectly decreased the risk of falls in the studied participants by alleviating depressive symptoms.

The reduction of risk of falls in patients attending music session may also be related to other factors. The patients who participated to the listening music sessions may have been more motivated to walk. Since physical activity decreases the risk of falls, the simple walk from bed to the music room may have on its own been sufficient to decrease the risk of falls in participants [31].

Also, music has been previously used as support of physical exercises for gait training in community dweller individuals, patients with Parkinson disease and older adults living in nursing homes [24, 25, 32]. Considering that falls usually occur while walking in older adults [33] and that gait irregularity has been identified as a marker of gait instability [26], the rhythmic component of music has been used to regularize gait with a synergistic effect combined with physical exercises [26]. Therefore, given the role of music, and particularly the rhythmic aspects of music in gait stability, it is certainly possible that music listening influenced fall risk. Also, in neurosciences, it has been demonstrated that performing, observing or imagining a movement activates the same neural brain network [34]. The equivalence between performed and imagined or observed movement has been used in rehabilitation to improve the physical performance of sportive individuals as well as patients with mobility impairments [35, 36]. Because the rhythmic component of music has been identified as the key element of improvement of gait stability in intervention combining music and physical activity, and because of motor brain equivalences, it could be suggested that listening to music could improve stability of gait and thus reduce the risk of fall in geriatric patients.

The patients of the intervention group had a significantly longer length of stay compared to the patients from the control group. Considering that comorbidities and poor functional is associated with a longer length of stay [37], it is possible that the patients from the intervention group had more complex medical issues and were more encouraged to attend the live music sessions because the medical team believed in the potential benefits of the music intervention. To reduce the effect of such confounding variables, we considered the patients' baseline characteristics in the statistical analyses. After controlling for such effects, the reduction in risk of falls seen in the music intervention group remained significant.

Our study was undertaken to improve the quality of care of geriatric patients hospitalized at St. Mary's Hospital Center and to promote the *Senior-Friendly Hospital* Approach. The main goals of this approach are to prevent functional decline as well as providing tailored quality care to the older inpatients [38]. As participation in the music sessions was on a voluntary basis, the allocation to groups (intervention vs control) was not randomized. This resulted in groups with unbalanced patients' characteristics and a selection bias. However, the methodology developed for this study and the positive outcome have laid a foundation for future randomized clinical trials using music listening in the GAU setting.

Conclusion

We report here an association between participation in music listening sessions and a decrease in the risk of falls as measured by the MFS. One of the possible explanations for this is that music may have had a mood-enhancing effect, i.e. alleviation of depressive symptoms which have been associated with a higher risk of falls. Another possible explanation is that patients had to walk to participate in the music listening sessions, and this physical activity coupled with musical stimulation may have positively transferred to a diminished risk of falls. Further research using a randomized trial design is needed to confirm this relationship.

Appendix 2

The CODEM instrument

Table 3. Scaling of CODEM

Scale	Category	% of cases	Content
0	Never	0%	The behavior is not shown during the interaction.
1	Rarely	1–24%	The behavior is only slightly indicated during the interaction.
2	Sometimes	25–49%	The behavior is shown in less than half of the interactions.
3	Often	51–75%	The behavior is shown in more than half of the interactions.
4	Mostly	76–99%	The behavior is shown in almost all interaction situations.
5	Always	100%	The behavior is always shown during the interaction.

Table 5. Overview of exploratory factor loadings after oblique rotation and confirmatory unstandardized and standardized factor loadings, standard errors (*SE*) and *t*-values (*T*) for CODEM, standardized

		Factor 1	Factor 2	Unstandardized	*SE*	*T*	Standardized
Verbal/content aspect	*Presentation 03*. She/he uses a sensible sentence structure.	**.87**	.50	1.68	.19	9.01	.89
	Presentation 04. She/he uses words according to their meaning.	**.86**	.40	1.62	.18	8.78	.88
	Presentation 05. She/he comes up with the right words.	**.92**	.39	1.53	.16	9.27	.91
	Comprehension 09. She/he understands complex questions and sentences.	**.80**	.72	1.20	.17	6.85	.75
	Comprehension 10. She/he responds sensibly to what is said.	**.90**	.65	1.40	.16	8.53	.86
	Remembering 13. She/he performs the task independently.	**.80**	.71	1.31	.18	7.46	.79
	Remembering 14. She/he communicates without memory aids of the other.	**.70**	.48	1.04	.17	6.24	.70
	Remembering 15. She/he remains on an issue.	**.88**	.61	1.38	.18	7.83	.82
Nonverbal/relationship aspect	*Presentation 01*. She/he signalizes the need to communicate.	.37	**.81**	.71	.17	4.19	.51
	Presentation 02. She/he shows interest in the interaction partner.	.50	**.89**	1.29	.15	8.79	.88
	Presentation 06. She/he shows emotions.	.49	**.84**	1.02	.18	5.72	.66
	Attention 07. She/he can make eye contact.	.51	**.75**	.99	.15	6.51	.72
	Attention 08. She/he maintains eye contact appropriately.	.57	**.59**	1.29	.15	8.83	.88
	Comprehension 11. He/she demonstrates appropriate nonverbal responses to what is said.	.71	**.73**	1.29	.18	7.32	.78
	Comprehension 12. She/he reacts to the feelings of the other.	.60	**.84**	1.36	.17	8.07	.84
Covariance (verbal, nonverbal)				.75	.06	11.80	.75

Note. For better illustration of the factor loading pattern, bold letters are used to indicate the factors with the highest loadings for each item.

Appendix 3

Mean ratings given by the two judges with the OERS for the first and last 10 minutes of the session

	Music Group		Television Group	
Emotions	First 10 minutes M (SD)	Last 10 minutes M (SD)	First 10 minutes M (SD)	Last 10 minutes M (SD)
Pleasure	2.26 (0.98)	2.82 (1.19)	1.56 (0.81)	1.64 (0.77)
Anger	1.00 (0.00)	1.03 (0.12)	1.03 (0.13)	1.00 (0.00)
Anxiety/fear	1.34 (0.71)	1.18 (0.30)	1.41 (0.55)	1.32 (0.67)
Sadness	1.16 (0.37)	1.29 (0.61)	1.31 (0.51)	1.11 (0.40)
Gen Alertness	4.81 (0.42)	4.79 (0.44)	5.00 (0.00)	4.96 (0.13)